Report for 2003CO71B: Urban Landscape Irrigation with Reclaimed Wastewater: Water Quality Assessment and Community Experience

- Conference Proceedings:
  - Qian, Y.L., 2003, Urban Landscape Irrigation With Reclaimed Wastewater: Opportunities and Potential Problems, in 2003 Water Reuse Workshop: Reuse It or Lose It!, Co-Sponsored by Rocky Mountain Water Environmental Association, AWWA Rocky Mountain Section, and Water Reuse Association, Golden, CO.
  - Qian, Y.L., 2003, Urban landscape Irrigation With Reclaimed Wastewater: Preliminary Findings, Presented in the 50th Rocky Mountain Regional Turfgrass Conference, Denver, CO.
- unclassified:
  - Qian, Y.L., 2004, Urban Landscape Irrigation With Recycled Wastewater: Preliminary Findings. Colorado Water Resources Research Insitute, Colorado State University, Colorado Water, 21(1), pp. 7-11.
  - Gejer, Melinda, 2003, Long Term Effects of Effluent Water Irrigation on Soil Nitrate and Phosphorus Profiles Under Turfgrass, Presented in the 2003 Research Experiences for Undergraduates Program in Water Research, Colorado State University, Fort Collins, CO.

Report Follows

Problem and research objectives

Growing concerns of our future water supply and more stringent wastewater discharge standards to surface water bodies have contributed to increasing interest in using recycled wastewater for urban landscape irrigation. Increasing numbers of landscape facilities and development areas have been switched to or plan to use recycled wastewater for irrigation in the western states.

Recycled wastewater (i.e. reclaimed wastewater) is treated wastewater from the community to meet a permit issued through Federal or State Water Acts. During treatment, suspended solids are removed, pathogens are disinfected, and partial to substantial reduction in nutrients occurs, depending on the level of treatment. However, recycled water may still contain different levels of dissolved solids, ions, nutrients (N and P), and other elements.

The growth in water reuse has created the needs to provide information on the chemical and biological properties of effluent water and to determine the effects of recycled wastewater irrigation on urban landscape soils, plants, and the ecosystem as a whole.

The primary objectives of the project are to:

1) To assess chemical properties of recycled wastewater for urban landscape irrigation; and
2) To evaluate landscape plants and soils that are currently under recycled wastewater irrigation.

Methodology

The procedures and methodology of the project involved:

1) Preparing and sending surveys to the wastewater treatment plants that are currently supplying recycled wastewater for urban landscapes along the Front Range of Colorado. Requesting data on effluent water analysis from wastewater treatment facilities, which include total suspended solids, turbidity, biological oxygen demand, chemical oxygen demand, E-coli, and other basic chemical characteristics.
2) Collecting water samples from irrigation ponds and irrigation sprinkler outlets on reuse sites to test salinity, individual mineral concentrations, and bicarbonate content.
3) Collecting and analyzing soil samples from reuse sites vs. landscape sites that have not used recycled wastewater.
4) Visual evaluations of the health of landscape plants on reuse sites.

Principal findings and significance

1) Golf courses are the earliest and leading urban landscape users of recycled wastewater in Colorado. Recently, the reuse practice has been extended to include some of the large parks, open spaces, and greenbelts. Survey data indicated that cost savings was not the main reason for using recycled wastewater for irrigation. Rather the availability and reliability of the water were the driving force for using recycled wastewater for irrigation.

2) Data from five advanced wastewater treatment plants in the Front Range of Colorado revealed that, although there were variations in water quality between wastewater treatment facilities, in all cases, the water quality of effluent exceeded the regulations in the terms of E-coli count, turbidity, and suspended solid.

3) The chemical constituent of recycled wastewater is dominated by sulfate, bicarbonate, chloride, and sodium. These 4 ions comprise of about 70% of total dissolved salts. The average electrical conductivity (EC) of 37 recycled wastewater samples from 6 reuse sites was 0.84 dS/m and the range was 0.47 to 1.32 dS/m. An electrical conductivity higher than 0.75 dS/m indicates the water may impose negative effects on salt sensitive plants. Periodic leaching of salts is required to mitigate the potential salinity problem. Adjusted sodium absorption ratio (SAR) of recycled wastewater from reuse sites ranged from 1.6 to 8.3. Based on the interactive effect of salinity and sodicity on soil infiltration and percolation, 90% of the water samples collected showed slight to moderate effects on soil infiltration and permeability. The average sodium and chloride concentrations of 37 water samples collected were 99 mg/L and 95 mg/L, respectively. Previous literature suggests that, with sprinkler irrigation, sodium and chloride toxicity could occur on sensitive plants when their concentrations exceed 70 and 100 mg/L, respectively. Therefore, sodium toxicity would likely to occur to sensitive landscape plants under long-term recycled wastewater irrigation. For sites with poor drainage and/or have a shallow water table present, chloride applied over time may also accumulate to a toxic level.

4) Although, typically the wastewater treatment systems have continuously evolved in response to the growth and regulatory requirements, our results indicated that soils from sites where recycled wastewater was used for prolonged time exhibited higher concentration of sodium, chloride, boron, and phosphorous than sites with surface water irrigation. However, the cation exchange sites occupied by magnesium and potassium were lower. Comparison of soil chemical properties before and 5 years after recycled wastewater irrigation on 2 golf courses also revealed the following findings: a) increased sodium content and sodium exchange percentage; b) increased boron content; and c) increased phosphorous content at the surface depth.

5) Quality decline of some conifer trees was often observed on golf courses with recycled wastewater for irrigation. Landscape managers also revealed that turf became more susceptible to drought stress after years of recycled wastewater irrigation. It is difficult to draw conclusions about the causes of the decline, although the degree of decline appeared to relate to water quality, species, soil texture, irrigation methods, and drainage effectiveness. More research is needed to define the causes of the decline and to study

the tolerance of different landscape plants to recycled wastewater irrigation.

From our initial study we found that, while recycled wastewater irrigation in urban landscapes is a powerful means of water conservation and nutrient recycling, potential problems associated with recycled wastewater irrigation do exist. These problems include a relatively high sodium concentration and the resulting changes in soil physical and chemical properties after long-term application of recycled wastewater. As landscape facilities and development areas plan to switch to recycled wastewater for irrigation, landscape managers must be prepared to face new challenges associated with the use of recycled wastewater. City landscape planners and managers need to understand the hidden costs in managing these landscapes to mitigate problems, such as higher water use for leaching; the need of frequent aerifications to maintain infiltration, percolation, and drainage; application of soil amendments to reduce sodium problems; soil and plant monitoring, etc.